Study on Shandong Expressway Network Planning Based on Highway Transportation System

Fei Peng [a], Yimeng Wang [b] and Chengjun Shi [c]

School of Automobile, Changan University, Xian 71000, China;

[a]pengfei0799@163.com, [b]sweety_crystal@163.com, [c]s781298@163.com

Abstract

In order to study the reasonable scale of the regional highway network. This paper analyzes the development status of comprehensive traffic network in Shandong province. Based on the consideration of the comprehensive transportation system, the reasonable scale of Shandong comprehensive traffic network is predicted by the combination of the modified connectivity method and the analogy analysis method. Combined with the actual development of Shandong Province, the scale of Shandong expressway is comprehensively determined. The results show that the rational scale of Shandong province expressway network is about 13000 km, which is determined by the method of systematic total amount control structure optimization.

Keywords

Traffic Network;Highway;Transportation System.

1. Introduction

The expressway is an important part of the integrated transportation system. The expressway has three outstanding advantages, namely, "transport capacity, speed and safety". So it plays an important role in improving the efficiency of modern logistics, improving the quality of passenger service and improving the market economy system. Since the end of 1980s, highways have been built in China, and the expressway has developed rapidly. The scale of the highway network has been increasing, which has improved the level of the overall highway network, optimized the transportation structure and alleviates traffic congestion, and promotes China's economic and social development and social progress. Based on the goal of transportation modernization, we must focus on building a reasonable, clear function, perfect layout and efficient service highway network, which is the main task of China's development at this stage and in the future.

Though under the condition of comprehensive transportation system, the level of highway planning in China has gradually improved, and the degree of network is improving. However, due to the complexity of transportation system and the changeable market demand, there still exists the phenomenon of blind planning and construction in the process of expressway network planning. The scale mileage of the expressway network is constantly breaking through, which leads to the waste of resources, the few traffic of the motorway and the serious loss.

2. Present situation of comprehensive traffic network in Shandong

2.1 Development status and problems

In 2013, the total mileage of the Shandong highway network was 253 thousand km, which was located in the second of China. The density of the road network is 161 km / 100 square kilometers, which was located in the first of China. (excluding the municipalities directly under the central government). The

high grade highway is about 40 thousand kilometers, and the mileage is the first in the country. The expressway reaches 4994 kilometers and reaches more than 91% of the county's urban area. Among them, Beijing-Shanghai, Beijing-Taiwan, Shenhai,. Jiguang and other highways run through the north and south, forming the five main and four horizontal network backbone.

According to the proportion of the overall structure of the highway network, the proportion of Shandong highway network to the total mileage of the highway is 2.10%, and the proportion is relatively high. But the proportion of the low grade highway should be increased, so that the connection between the expressway and the branch road network can be strengthened, and the shunting effect of the branch road network can be strengthened. At present, the congested section of Shandong highway is Qingyin high speed, Beijing-Shanghai high speed, Beijing-Fuzhou high speed. The high crowding degree was 0.89, 0.74 and 0.72 respectively. The degree of congestion in the other sections of the province is not high, especially in the Yantai and Weihai areas which is at the end of the province, and the utilization of the expressway is low. So that the layout of the freeway needs to be further optimized.

2.2 Analysis on the development law of expressway network

Social and economic activities generate flow of people and logistics, and produce traffic demand.At the same time, the infrastructure of traffic supply is needed to support the infrastructure. As an important part of the traffic system, the expressway plays a very important role. The relationship between the expressway and the economy is mutual promotion and mutual influence, as shown in Figure 1.

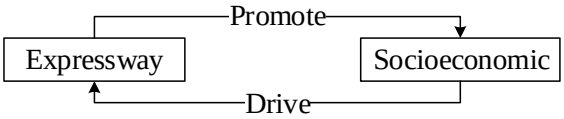

Fig. 1 The relationship between the expressway and the economy.

Analysis of the expressway and the statistical data of GDP in Shandong Province, It can be seen that the Shandong province's expressway and GDP basically conform to the "fish mouth shape" development model, as shown in Figure 2. Although the mileage of the expressway is growing at a stage, it is generally on the rise, and it is moderately ahead of the social and economic development. By 2013, there was a new stage of gentle trend.

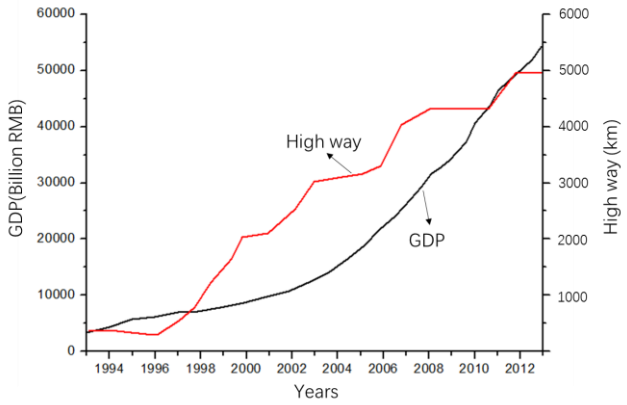

Fig. 2 The change of Shandong Expressway and GDP.

The development stage of the expressway in Shandong is not very obvious. It has experienced the development stage, rapid growth stage and mature stage three stages, and currently in the period of transition to saturation stage, the growth speed is gradually over 0, as shown in Figure 3.

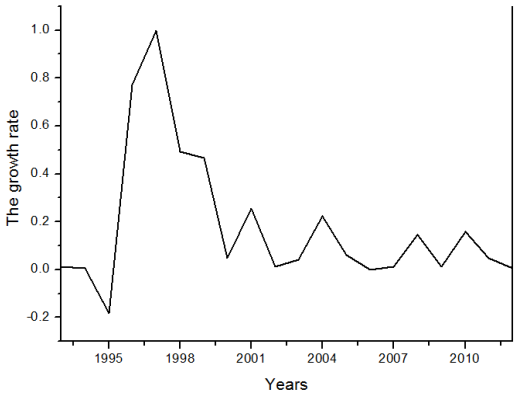

Fig. 3 The growth rate of Expressway in Shandong Province.

3. The determination of the rational scale of Shandong comprehensive traffic network

3.1 Node connectivity method

The Node connectivity model are shown in formula (1):

$$L = K * \xi * \sqrt{A * N(1 - \beta)} \quad (1)$$

L: Road network scale (km);

K: The connectivity of the road network. The value of K is different with the connectivity of road network. It is mainly divided into three types: when the road network is "tree" structure, the value is 1.0. When the road network is grid mesh, the value is 2.0. And when the road network is grid + diagonal type, the value is 3.

N: Nodes in the region;

A: Regional land area (km2)

ξ: Deformation coefficient of road network

Node connectivity method takes into account the connectivity between expressway network and regional nodes. It is considered that within a certain area, with the increase of connectivity of road network, there is a mature road network layout, which can make regional social and economic development healthfully. However, the parameters considered in the node connectivity model are difficult to determine, and there are to many qualitative components.

3.2 Modified node connectivity method

Through the analysis, it is found that the model does not consider the influence of the node importance and the degree of congestion on the connectivity when determining the connectivity of the road network. When determining the deformation coefficient of the road network, the ratio of the actual mileage to the length of the line between the nodes is used, but it does not take into account that the direction of the actual line is not necessarily reasonable. When determining the influence factors of the road network scale, only the area of the regional state is considered, but whether the area is suitable for road repair is not taken into account. Therefore, the traditional model can not meet the exact prediction of the reasonable scale of different regional road network, so we need to modify some parameters to make it adapt to the requirements of different regions.

The modified connectivity method is introduced:

$$L = K_{\alpha} * \xi_{\alpha} * \sqrt{A * N(1 - \beta)} \quad (2)$$

Kα: Modified road network connectivity

ξα: Modified deformation coefficient of road network

β: The revision coefficient of land area. It is defined as the proportion of the area that is not suitable for road repair.

$$\beta = \frac{S}{A} \tag{3}$$

S: Lakes, ecological protection zones, mountain peak valleys, islands and other areas that not suitable for mend a road.

In the modified node connection formula, four parameters such as the number of nodes N, connectivity Kα, and the deformation coefficient of the road networkξα，β need to be determined.

Considering node selection, considering the difference between expressway and railway connection demand for cities and towns, the connectivity of highways is higher, so expressway is the standard. A city with more than 150 thousand of the urban population in Shandong province is chosen as the calculation node. According to the prediction of the urban population scale in the new urbanization plan of Shandong Province, the total number of nodes N is 110.

According to the selected 110 nodes, the transport potential and transportation conditions of Shandong province are calculated, and the weights of the nodes are weighted to get the node importance. Then hierarchical cluster analysis is used to divide the nodes into layers, and the weighted fuzzy connectedness of Shandong comprehensive transportation network in 2015 is calculated to be 2.0. According to the requirements of the mid long term development plan of Shandong comprehensive transportation network, the overall level of Shandong province has reached the requirements of the moderately developed countries in 2030, and the comprehensive traffic network will be further encrypted. It is predicted that the road network of Shandong Province in 2030 tends to be mature, and the weighted fuzzy connectivity Kα is 2.8-3.0.

Before determining the deformation coefficient of the road network, the regional traffic location line of Shandong province is determined first. The geographical location, regional development, resource distribution, town layout, population distribution and other factors in Shandong province are analyzed, and the traffic location line of Shandong province is obtained. From the analysis of the alignment of the traffic location line and the straight line between the city of Shandong Province, a rough calculation of the deformation coefficient of the road network ξα in Shandong province is 1.1.

According to the terrain conditions, natural environment and the distribution of ecological water system in Shandong Province, the value of β in Shandong province is estimated to be 0.5.

According to the parameters determined above and formula (1), it can be predicted that the reasonable scale of the comprehensive traffic network in Shandong Province in 2030 is 12515-13409km.

3.3 Contrastive analysis

Developed countries or moderately developed countries experience shows that the development of the comprehensive transportation network, infrastructure construction has been pressure in a stable state and facility size growth to the inflection point of the growth curve. Therefore, the analogy method can be used to predict the development level of the comprehensive traffic network in 2030 in Shandong province. The development level of the integrated traffic network in Korea, Japan, the United States, Germany and the United Kingdom was analyzed.

The density of the comprehensive traffic network in Shandong is 2.01, South Korea and Japan are 1.61, and 1.97, respectively. It is predicted that the comprehensive density range of Shandong traffic network is 1.61-1.97 in 2030. It is assumed that Shandong province has little change in area and population, and the target of economic development is 7%. It is estimated that by 2030, the gross national product of Shandong will reach 3 trillion US dollars. Meanwhile, considering the rapid development of Shandong's fast rail network, the corresponding comprehensive transport network will be 12511km-15234km.

4. Conclusion

Taking Shandong Province as an example, this paper analyzes the development status of the comprehensive transportation network in Shandong Province, and adopts the modified nodal connection method and comparative analysis method to determine the reasonable scale of the expressway network. After comparing with the developed countries, and considering the factors of future urban development, the level of economic development, geographical features, comprehensive traffic integration, sustainable development, with expert consultation. the reasonable scale of the comprehensive transportation network in Shandong province was determined to be about 13000km in 2030.

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